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TITLE: Deposition of thin dielectric layer - by sequential deposition of oxide and nitride thin films in low pressure CVD tube

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Equivalent Abstract Text - ABEQ (1):

Prodn. of a low defect density ultra thin oxide/nitride/oxide (ONO) dielectric is new and comprises producing a thin film of oxide (2) by deposition in an LPCVD tube; slowly depositing a thin layer of silicon nitride (3), in situ in said LPCVD tube, from a gas mixture of SiCl2H2/NH3, at a temperature in the range between 720-800 deg.C, at a pressure in the range between 13.3-106.7 Pa (100-800 mT) and gas flows adjusted to achieve a deposition rate of 1 nm/min. on said thin film of oxide, to a thickness of at least 3 nm and such that the resulting oxide-nitride structure has a thickness in the range from 4 nm up to less than 10 nm, and forming a thin layer of oxide (4) thereon to a thickness such that the thickness of the resulting composite ONO is under 10 nm, the oxide (4) being formed by thermal reoxidation of the

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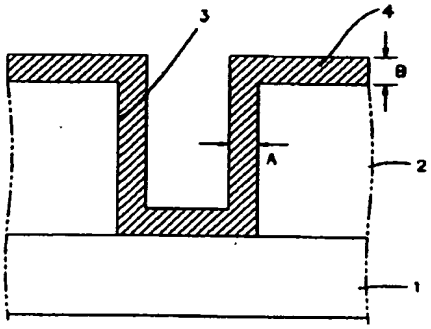
(54) CVD of silicon containing film using Si2H6

(57) A method of forming a thin film for a semiconductor device which applies disilane (Si_2H_6) to chemical vapor deposition is capable of improving deposition rate and step coverage of the thin film although the thin film is deposited at lower temperatures, thereby improving productivity and reliability of the semiconductor device. In order to form various thin films, Si_2H_6 and N_2O, or Si_2H_6 and O_2 are applied for an oxide film, Si_2H_6 and NH_3 for a nitride film, Si_2H_6, N_2O, and NH_3 for a nitride-oxide film, Si_2H_6, O_2, and PH_3 or TMOP for a PSG film, and Si_2H_6, O_2, B_2H_6 or TMOB, and PH_3 or TMOP for a BPSG film. Also, a system for the method according to the present invention is used among an atmospheric pressure chemical vapor deposition system, low pressure chemical vapor deposition system, and plasma chemical vapor deposition system.

FIG. 1



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[Table.4]

	gas	deposition method					
		LPCVD		PECVD		APCVD	
		deposition rate (Å/min)	step coverag -e (%)	deposit -ion rate (Å/min)	step coverag -e (%)	deposit -ion rate (Å/min)	step coverag -e (%)
oxide film	Si_2H_6/N_2O	15-500	≥95	50-9000	≥90	x	x
	Si_2H_6/O_2	15-1000	≥90	x	x	500 -5000	≥90
nitride film	Si_2H_6/NH_3	5-500	≥95	50-9000	≥90	x	x
BPSG	Si_2H_6/PH_3(TMOP)/B_2H_6(TMOB)/O_2	50-9000	≥90	50-9000	≥90	500 -5000	≥90
PSG	$Si_2H_6/O_2/PH_3$(TMOP)	50-6000	≥90	50-9000	≥90	500 -5000	≥90

[0014] Now, the conditions of the method of forming the thin film according to the present invention by each process equipment will be described.

[0015] First, condition of a method of forming the thin film by using a LPCVD equipment will be described.

[0016] That is, an oxide (SiO_2) film was formed under condition below.

[0017] Temperatures in a reaction chamber ranged from 500 to 850°C, and pressures therein were between 0.1 and 9 torr. Disilane (Si_2H_6), main material gas, was flowed into the chamber at 10 to 400sccm, and N_2O at 100 to 10000 sccm (Here, sccm is standard cm^3/min). At this time, more desirable ranges of temperatures and pressures are between 650 and 800°C and between 0.3 and 5 torr, respectively. When the oxide film was deposited under the above condition, the deposition rate thereof ranged from 15 to 500 Å/min, and the step coverage thereof was 95%.

[0018] In accordance with another method of forming the oxide film, temperatures and pressures in the reaction chamber ranged between 300 and 700°C and between 0.1 and 9 torr, respectively. Disilane (Si_2H_6) was flowed into the chamber at 10 to 500sccm and O2 at 20 to 1000sccm. Here, more desirable ranges of temperatures and pressures are between 300 and 550°C and between 0.1 and 5 torr, respectively. When the oxide film was deposited under the above condition, the deposition rate thereof ranged from 15 to 4000 Å/min, and the step coverage thereof was 90%.

[0019] The LPCVD applying disilane and N_2O, or disilane and O_2 according to the present invention shows that the deposition rate of the LPCVD according to the present invention is much improved compared with that of the conventional method using SiH_4 and N_2O, or SiH_4 and O_2, which were lower than 10 Å/min, and about 100 Å/min, respectively. In addition, the step coverage of the method of forming the oxide film according to the present invention was over 90%, while the step coverage according to the conventional method thereof applying SiH_4 and O_2 is about 60%. Additionally, even though the thin film was formed at lower temperatures by CVD according to the present invention, the result of the step coverage was still improved.

[0020] Next, a nitride (Si_3N_4) film was formed under condition below.

[0021] Temperatures in a reaction chamber ranged from 350 to 800°C, and pressures therein were between 0.1 and 9 torr. Disilane (Si_2H_6) was flowed into the chamber at 5 to 500sccm, and NH3 at 15 to 1000 sccm. At this time, more desirable ranges of temperatures and pressures are between 400 and 800°C and between 0.3 and 5 torr, respectively. When the nitride film was deposited under the above condition, the deposition rate thereof ranged from 5 to 500 Å/min, and the step coverage thereof was over 95%. The conventional method of depositing the nitride film applied dichlorine-silicate (SiH_2Cl_2) and NH_3, and temperature at 700°C and pressure at 0.4 torr in the reaction chamber. Here, the deposition rate thereof was 30 Å/min. According to the present invention, temperature applied to the method of forming the nitride film dropped from 700° to 350°C. However, the deposition rate of the thin film was much improved. Also, in spite of the process at a low temperature, the step coverage according to the present invention does not fall exceedingly.

[0022] A nitride-oxide (SiOxNy) film was formed under condition below.

[0023] Temperatures in a reaction chamber ranged from 350 to 800°C, and pressures therein were between 0.1 and 9 torr. Disilane and NH_3, or disilane and N_2 were applied to the deposition. At this time, more desirable ranges of temperatures and pressures are between 400 and 800°C and between 0.3 and 5 torr, respectively.

[0024] A BPSG film, the planarized film, was deposited under condition below.

[0025] Temperatures in a reaction chamber ranged from 350 to 800°C, and pressures therein were between 0.1 and